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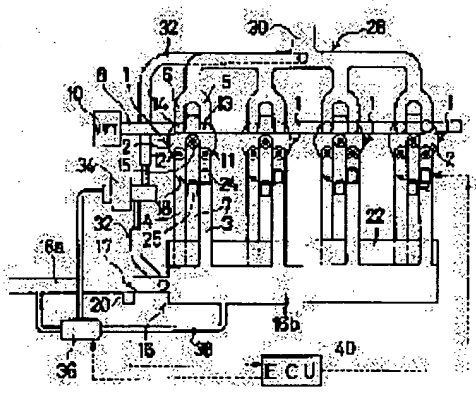
(54) EXHAUST GAS REFLUX DEVICE FOR ENGINE



(57)Abstract:
PURPOSE: To improve an effect to reduce the generation of NOX owing to EGR as worsening of exhaust gas emission owing to the generation of HC is prevented occurring.
CONSTITUTION: Simultaneously with opening of side ports 3 and 4, as main intake ports, to a combustion chamber 2, center port 7 is opened and air-fuel mixture is fed through a center port 7 to the interior of a combustion chamber 2. One end of an EGR passage 32 is connected to an exhaust manifold 28 and the other end thereof is connected to side ports 3 and 4 through an EGR valve 34. An ECU 40 is operated to extend an overlap period between the opening periods of exhaust valves 1 and 14 and the opening periods of intake valves 11 and 12 by delaying the closing times of exhaust valves 13 and 14 in a specified region, where the opening of a throttle valve 17 is below a specified value, through actuation of a VVT timing varying means 10 and open the EGR valve 34 to effect reflux of exhaust gas to the side ports 3 and 4.

CLAIMS

[Claim(s)]

[Claim 1] the gaseous mixture which supplies the gaseous mixture of air and a fuel to a combustion chamber after carrying out opening to the main suction port which carries out opening to a combustion chamber, and is opened and closed by the inlet valve at the above-mentioned combustion chamber, and being opened and closed by the closing motion valve and this closing motion valve's having opened -- with a feed zone In the engine with which it has the exhaust air port which carries out opening to the above-mentioned combustion chamber, and is opened and closed with an exhaust valve, and the valve-opening stage of the above-mentioned closing motion valve was set up at the stage later than the valve-opening stage of the above-mentioned inlet valve A stage adjustable means of the above-mentioned exhaust valve to change a clausilium stage at least, the above -- gaseous mixture -- with the above-mentioned stage adjustable means in the specific region included in the operating range to which gaseous mixture is supplied from a feed zone, so that the duplication period of the valve-opening period of the above-mentioned exhaust valve and the valve-opening period of the above-mentioned inlet valve may be expanded within limits to which the valve-opening period of the above-mentioned exhaust valve does not overlap the valve-opening period of the above-mentioned closing motion valve compared with other fields The stage control means which delays the clausilium stage of the above-mentioned exhaust valve, and an exhaust air reflux means to make exhaust gas flow back to the above-mentioned main suction port, Exhaust air reflux equipment of the engine characterized by having the exhaust air reflux control means to which the amount of exhaust air reflux by the above-mentioned exhaust air reflux means is made to increase from the other field in the above-mentioned specific region.

[Claim 2] The above-mentioned specific region is exhaust air reflux equipment of the engine characterized by containing an engine load to the field below fixed.

[Claim 3] Exhaust air reflux equipment of the engine characterized by constituting the above-mentioned exhaust air reflux control means from an above-mentioned specific region in the exhaust air reflux equipment of an engine according to claim 2 so that the rate of exhaust air reflux by the above-mentioned exhaust air reflux means may be decreased with increase of an engine load.

[Claim 4] the exhaust-air reflux equipment of an engine according to claim 2 or 3 -- setting -- the above -- gaseous mixture -- the exhaust-air reflux equipment of the engine characterized by to constitute from an above-mentioned specific region at least so that the above-mentioned closing-motion valve may open on the both sides of the 1st valve-opening period when valve opening is slower than the valve-opening stage of the above-mentioned inlet valve, and the 2nd valve-opening period when valve opening is

earlier than the valve-opening stage of the above-mentioned exhaust valve while having made the space in a feed zone into closing space.
[Claim 5] Exhaust air reflux equipment of the engine characterized by constituting the above-mentioned stage control means from an above-mentioned specific region in the exhaust air reflux equipment of an engine according to claim 4 so that the both sides of the clausilium stage of the above-mentioned exhaust valve and a valve-opening stage may be delayed compared with other fields.
[Claim 6] the maximum amount of marginal exhaust air reflux in the range and abbreviation as for which the peak price of the amount of exhaust air reflux by the above-mentioned exhaust air reflux means does not decrease an inhalation air content in the exhaust air reflux equipment of an engine according to claim 1 to 5 -- the exhaust air reflux equipment of the engine characterized by setting it as an equal amount.
[Claim 7] Exhaust air reflux equipment of the engine characterized by setting up the valve-opening stage of the above-mentioned inlet valve when later than a piston top dead center, coincidence, or this in the exhaust air reflux equipment of an engine according to claim 1 to 6.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] gaseous mixture for the main suction port to supply the gaseous mixture of air and a fuel to a combustion chamber independently, as for this invention -- a feed zone is related with the exhaust air reflux equipment of the engine which carries out opening to the above-mentioned combustion chamber.
[0002]
[Description of the Prior Art] Conventionally, what is shown in JP,62-28032,A is known as engine exhaust air reflux equipment. the gaseous mixture for supplying the gaseous mixture which mixed air and a fuel beforehand to the above-mentioned combustion chamber with this equipment apart from the main suction port (an official report the 1st suction port and the 2nd suction port) with the usual inlet valve -- the feed zone (the 3rd suction port) is carrying out opening to this combustion chamber. this gaseous mixture -- the above-mentioned inlet valve and the same closing motion valve are prepared in a feed zone, and that valve-opening stage is set up at the stage later than the valve-opening stage of the above-mentioned inlet valve. after the inhalation-of-air initiation which leads the above-mentioned main suction port according to such equipment, and this -- becoming independent -- the above -- gaseous mixture -- by supplying the gaseous mixture generated beforehand to a combustion chamber from a feed zone, a combustion chamber is stratification-ized and good Lean combustion is

realized.
[0003] By the way, with such equipment, although fuel rarefaction is made sharply on the whole, since the part used as the air-fuel ratio which NOx tends to generate exists locally, reduction of such NOx serves as a technical problem. then -- this equipment -- exhaust air -- the above -- gaseous mixture -- reduction of NOx is achieved by making a feed zone flow back and making combustion within a gas column make it slow.
[0004]
[Problem(s) to be Solved by the Invention] as mentioned above, the above -- gaseous mixture -- a feed zone -- gaseous mixture -- such [since it is a thing aiming at stratification-izing of the combustion chamber by supply / that opening area / as opposed to a combustion chamber compared with the main suction port / is small, and] gaseous mixture -- even if it makes exhaust air flow back to a feed zone -- so much -- coming out -- it is hard to expect sufficient NOx reduction effectiveness. On the other hand, although it is possible to secure more amounts of exhaust air reflux if exhaust air is flowed back to the main suction port with a comparatively large opening area, there is a possibility that increase of HC (unburnt hydrocarbon) may be caused by the fall of combustion stability, and aggravation of exhaust air emission may arise with the increment in such an amount of exhaust air reflux.
[0005] This invention aims at offering the exhaust air reflux equipment of the engine which can reduce an NOx yield effectively in view of such a situation, controlling HC generating.
[0006]
[Means for Solving the Problem] As above-mentioned The means for solving a technical problem, this invention the gaseous mixture which supplies the gaseous mixture of air and a fuel to a combustion chamber after carrying out opening to the main suction port which carries out opening to a combustion chamber, and is opened and closed by the inlet valve at the above-mentioned combustion chamber, and being opened and closed by the closing motion valve and this closing motion valve's having opened -- with a feed zone In the engine with which it has the exhaust air port which carries out opening to the above-mentioned combustion chamber, and is opened and closed with an exhaust valve, and the valve-opening stage of the above-mentioned closing motion valve was set up at the stage later than the valve-opening stage of the above-mentioned inlet valve A stage adjustable means of the above-mentioned exhaust valve to change a clausilium stage at least, the above -- gaseous mixture -- with the above-mentioned stage adjustable means in the specific region included in the operating range to which gaseous mixture is supplied from a feed zone, so that the duplication period of the valve-opening period of the above-mentioned exhaust valve and the valve-opening period of the above-mentioned inlet valve may be expanded within limits to which the valve-opening period of the above-mentioned exhaust valve does not overlap the valve-opening period of the above-mentioned closing motion valve compared with other

fields It has the stage control means which delays the clausilium stage of the above-mentioned exhaust valve, an exhaust air reflux means to make exhaust gas flow back to the above-mentioned main suction port, and the exhaust air reflux control means to which the amount of exhaust air reflux by the above-mentioned exhaust air reflux means is made to increase from the other field in the above-mentioned specific region (claim 1).

[0007] The above-mentioned specific region has the desirable field where an engine load is contained to the field below fixed (claim 2).

[0008] in this case, in the above-mentioned specific region, the rate of exhaust air reflux by the above-mentioned exhaust air reflux means is decreased with increase of an engine load -- as -- constituting the above-mentioned exhaust air reflux control means **** -- (claim 3) and the above -- gaseous mixture, while making space in a feed zone into closing space That (claim 4) which is constituted so that the above-mentioned closing motion valve may be opened on the both sides of the 1st valve-opening period when valve opening is slower than the valve-opening stage of the above-mentioned inlet valve, and the 2nd valve-opening period when valve opening is earlier than the valve-opening stage of the above-mentioned exhaust valve is more desirable in the above-mentioned specific region at least. About this equipment according to claim 4, it is more desirable to constitute the above-mentioned stage control means so that the both sides of the clausilium stage of the above-mentioned exhaust valve and a valve-opening stage may be delayed compared with other fields in the above-mentioned specific region (claim 5).

[0009] moreover, the maximum amount of marginal exhaust-air reflux in the range and abbreviation as for which the peak price of the amount of exhaust air reflux by the above-mentioned exhaust air reflux means does not decrease an inhalation air content -- it depends and outstanding effectiveness like the after-mentioned is acquired by what (claim 7) it is set as an equal amount, or the valve-opening stage of (claim 6) and the above-mentioned inlet valve is set up for when later than a piston top dead center, coincidence, or this.

[0010]

[Function] By expanding the duplication period of an exhaust valve valve-opening period and an inhalation-of-air valve-opening valve period in a specific region, by increasing the so-called amount of internals EGR, and increasing the so-called amount of external EGR(s) by the exhaust air reflux means, sufficient amount of exhaust air reflux for reduction of NOx is secured, and, according to equipment according to claim 1, a pumping loss is also reduced. and -- this specific region -- gaseous mixture -- while a combustion chamber is stratification-ized by the gaseous mixture from a feed zone, in order for the combustion gas containing HC once discharged from the exhaust air port on the occasion of the above-mentioned internal EGR to be again pulled back by the combustion chamber and to afterburn in the above-mentioned duplication period,

increase of HC yield also in accordance with the amount of exhaust air reflux also being increased as mentioned above is suppressed, and exhaust air emission is kept good.
[0011] Here, with equipment according to claim 2, since the above-mentioned specific region is a low load field, while NOx depressant action sufficient in this low load field and a reduction operation of a pumping loss are secured, in the heavy load field which are fields other than the above-mentioned specific region, the high power demanded in this heavy load field is secured by stopping the above-mentioned internal EGR and Exterior EGR.
[0012] Furthermore, with equipment according to claim 3, also in the above-mentioned specific region, the engine power corresponding to a demand is secured by stopping the amount of external EGR(s) as an engine load increases.
[0013] here -- the above -- gaseous mixture -- the space in a feed zone -- the time of valve opening of closing space, then the above-mentioned closing motion valve -- gaseous mixture -- after supplying the gaseous mixture in a feed zone to a combustion chamber -- the combustion gas of this combustion chamber -- reverse -- gaseous mixture -- by closing a closing motion valve, after incorporating in a feed zone gaseous mixture -- without it uses a special air pressurization means by being able to produce differential pressure between combustion chamber internal pressure in a feed zone, and using this differential pressure -- the above -- gaseous mixture -- supplying is possible. Moreover, like claim 4 publication, if a closing motion valve is opened at least in the above-mentioned specific region in the 2nd valve-opening period (period when the valve-opening stage of a closing motion valve is earlier than the valve-opening stage of an exhaust valve) in addition to the above-mentioned valve-opening period (namely, 1st valve-opening period) this 2nd valve-opening period -- the high-pressure combustion gas of the above-mentioned combustion chamber -- further -- gaseous mixture -- the inside of a feed zone -- pushing in -- gaseous mixture -- the pressure up of the inside of a feed zone can be carried out further, and it becomes possible to fully maintain the above-mentioned differential pressure. in addition, the gaseous mixture by increase of the differential pressure according to installation of the above-mentioned combustion gas in the above low load fields although the installation of combustion gas itself [such] becomes the factor which reduces the combustion stability of gaseous mixture, and the high temperature of combustion gas -- combustion stability is maintainable with promotion of evaporation atomization of the gaseous mixture in a feed zone.
[0014] Furthermore, since not only the clausilium stage of the above-mentioned exhaust valve but a valve-opening stage is delayed with equipment according to claim 5 in the above-mentioned specific region, i.e., a low load field, compared with other fields, it controls that the duplication period of the valve-opening period of an exhaust valve and the valve-opening period of the above 2nd will be reduced by delay of this valve-opening stage, and combustion gas escapes to an exhaust air port side in this duplication period by it -- having -- this -- gaseous mixture -- the vasopressor action in a

feed zone is maintained by slight height. on the other hand, fields other than the above-mentioned specific region -- namely, -- especially -- combustion gas -- gaseous mixture -- even if it does not introduce in a feed zone -- sufficient gaseous mixture -- in the heavy load operating range which can secure feed zone internal pressure by bringing forward the valve-opening stage of an exhaust valve, and expanding the above-mentioned duplication period rather than the above-mentioned specific region, combustion gas misses to an exhaust air port side positively in this duplication period -- having -- the above -- gaseous mixture -- installation of the excessive combustion gas into a feed zone is prevented, and good flammability is secured. moreover, gaseous mixture -- it also prevents the inside of a feed zone carrying out a pressure up superfluously, and having a bad influence on fuel injection.

[0015] With equipment according to claim 6, since the peak price of the amount of exhaust air reflux by the above-mentioned exhaust air reflux means is set as the amount almost equal to the amount of inhalation-of-air marginal exhaust air reflux in which the amount of new air conduction ON from the main suction port begins to decrease with increase of this amount of exhaust air reflux, the maximum NOx reduction operation in within the limits which does not have a bad influence on engine power is secured.

[0016] With equipment according to claim 7, when the valve-opening stage of the above-mentioned inlet valve is later than a piston top dead center, coincidence, or this, are set up. Namely, since the duplication period of the valve-opening period of an exhaust valve and the valve-opening period of an inlet valve is set as the period after the above-mentioned piston top dead center, In this duplication period, the piston will surely descend, the combustion gas discharged from the above-mentioned exhaust air port is more certainly pulled back by the combustion chamber with the negative pressure by the above-mentioned piston descent, and the amount of internals EGR is raised by this.

[0017]

[Example] The example of this invention is explained based on a drawing.

[0018] Drawing 1 and the engine shown in 2 are equipped with two or more cylinders 1, and the combustion chamber 2 which carries out volume change with actuation of the piston outside drawing is formed in each cylinder 1. The 1st side port 3 of a Uichi Hidari pair and the 2nd side port 4 which are the main suction port, the same 1st exhaust air port 5 of a Uichi Hidari pair and the 2nd exhaust air port 6, and the single pin center,large port 7 carry out opening to each combustion chamber 2, and the ignition plug of **** is prepared in the abbreviation center section of each combustion chamber 2.

[0019] Both the above-mentioned side ports 3 and 4 are formed ranging from one flank to a combustion chamber 2 of the cylinder head of ****, and both the exhaust air ports 5 and 6 are formed ranging from the other flanks to a combustion chamber 2 of the above-mentioned cylinder head. The pin center,large port 7 is located between both the above-

mentioned side ports 3 and four comrades, and is carrying out opening into the combustion chamber 2 in the location near the above-mentioned ignition plug.
[0020] The opening part of the 1st and 2nd side port 3 and 4 of the above to the above-mentioned combustion chamber 2 It is opened and closed by the 1st and 2nd inlet valve 11 and 12, respectively, and the opening part of the 1st and 2nd exhaust air ports 5 and 6 to a combustion chamber 2 It is opened and closed with the 1st and 2nd exhaust valve 13 and 14, respectively, and the opening part of the pin center,large port 7 to the above-mentioned combustion chamber 2 is opened and closed with the timing valve (closing motion valve) 15. The closing motion drive of these valves 11-15 is carried out by the valve gear of **** which consists of a cam shaft etc., and the phase of a valve-opening period is shifted by actuation of the valve timing adjustable device (stage adjustable means; VVT is called hereafter.) 10 connected with the exhaust air cam shaft 8 especially about the exhaust valves 13 and 14.
[0021] More concretely the valve-opening period of exhaust valves 13 and 14 The period when the above VVT10 is shown by curvilinear 42A of drawing 2 in the state of OFF, It is switched to the period from a front point in time to the next piston top dead center from a piston bottom dead point. Conversely namely, VVT10 in the state of ON It is switched to the period of the time of passing a little next piston top dead center from the time between the period shown by curvilinear 42B, i.e., the valve-opening stage shown by the above-mentioned curvilinear 42A, and a piston bottom dead point. The valve-opening period of inlet valves 11 and 12 is set as the period of the time of passing a little next piston bottom dead point from the period (a piston top dead center near [i.e., / above-mentioned]) shown with a curve 44. therefore, when switched to the period when the valve-opening period of exhaust valves 13 and 14 is shown by the above-mentioned curvilinear 42B by the duplication period of this valve-opening period and the valve-opening period of the above-mentioned inlet valves 11 and 12 turning into 0 or a minute period when the valve-opening period of exhaust valves 13 and 14 is switched to the period shown by the above-mentioned curvilinear 42A, this valve-opening period and the valve-opening period of the above-mentioned inlet valves 11 and 12 are comparatively long -- period duplication carries out.
[0022] The valve-opening period of the timing valve 15 is set as the period by the front point in time (at the time in the middle of a compression stroke) rather than the next piston top dead center from the front time for a while from the piston bottom dead point in the period shown with a curve 46, i.e., the valve-opening period of the above-mentioned inlet valves 11 and 12. Therefore, the valve-opening stage of this timing valve 15 is set up at the stage later than the valve-opening stage of the above-mentioned inlet valves 11 and 12, and clausilium of the above-mentioned inlet valves 11 and 12 is carried out during the valve-opening period of this timing valve 15.
[0023] Air installation to each above-mentioned side ports 3 and 4 is performed through an inlet pipe 16. This inlet pipe 16 has common inlet-pipe 16a and surge tank 16b of the

downstream of the inhalation-of-air upstream, and each above-mentioned side ports 3 and 4 are connected to this surge tank 16b. The throttle valve 17 which operates according to accelerator actuation, and the throttle sensor 20 which detects the opening of this throttle valve 17 are formed in above-mentioned common inlet-pipe 16a.

[0024] Among both the above-mentioned side ports 3 and 4 and the pin center,large port 7, the side injector 24 and the pin center,large injector 25 are arranged in the 1st side port 3 and the pin center,large port 7, respectively, the swirl control valve 18 which opens and closes this is formed in the 2nd side port 4, and the closing motion drive of each swirl control valve 18 is carried out by the actuator of ****. And after this swirl control valve 18 has closed, a swirl is formed in a combustion chamber 2 by performing inhalation of air only from the 1st side port 3 of the above.

[0025] gaseous mixture [in / each pin center,large port 7 is connected to the common surge tank 22, and / with these pin center,large port 7 and the above-mentioned surge tank 22 / this invention] -- the feed zone is constituted and the building envelope is closed. And the fuel injected from the above-mentioned pin center,large injector 25 is mixed with air in this pin center,large port 7, and, thereby, gaseous mixture is formed.

[0026] Said exhaust air ports 5 and 6 are connected to the common exhaust pipe 30 through the exhaust manifold 28, and the flueway is constituted by these. The end of the exhaust air reflux path (an EGR path is called hereafter.) 32 is connected to the set part of the above-mentioned exhaust manifold 28. The other end of this EGR path 32 is connected to the above-mentioned surge tank 16b through the EGR valve 34 in the pars intermedia (at the example of drawing, it is the abbreviation boundary part of the common inlet pipe 16 and surge tank 16b) of the above-mentioned inlet pipe 16. Therefore, after the above-mentioned EGR valve 34 has opened, the exhaust air in an exhaust manifold 28 flows back to each main suction ports 3 and 4 through the above-mentioned EGR path 32 and surge tank 16b.

[0027] Let this EGR valve 34 be a diaphragm valve. The air passage 38 allotted to these and juxtaposition is connected to the above-mentioned common inlet-pipe 16a and surge tank 16b, and the part is connected to a part for the air induction of the above-mentioned EGR valve 34 through the duty solenoid valve 36, respectively while being an air passage 38. And it is possible by changing the opening of each duty solenoid valve 36 in the input of an electrical signal to adjust the opening of the above-mentioned EGR valve 34.

[0028] The detecting signal of each sensors including the above-mentioned throttle sensor 20 is inputted into ECU (control unit; a stage control means and exhaust air reflux control means)40, and opening control of each above-mentioned EGR valve 34, on-off control of VVT10, closing motion control of the swirl control valve 18, fuel-injection control of each injectors 24 and 25, etc. are performed by this ECU40. Concretely, this ECU40 is constituted so that the following control action may be performed.

[0029] 1) Closing motion control of the swirl control valve 18 : as shown in drawing 3 , engine-speed N closes the swirl control valve 18 in a with an engine speed [N] of less than one set up beforehand low rotation field, and the above-mentioned engine-speed N opens the swirl control valve 18 in a with an above-mentioned engine speeds [N] of one or more high rotation field.
[0030] 2) Opening control of the EGR valve 34 : as straight lines 48A and 48B show to drawing 4 in the above-mentioned low rotation field, a throttle valve 17 opens the EGR valve 34 so that the highest EGR rate may be acquired in the state of a close by-pass bulb completely, and decrease the opening of the EGR valve 34 so that an EGR rate may decrease linearly according to the increment in the opening of a throttle valve 17, and throttle opening makes the EGR valve 34 a close by-pass bulb completely in the field and high rotation field more than predetermined opening thetao. Here, an EGR rate (%) is given by the following formula.
[0031]
[Equation 1] (EGR rate) =100xgermanium/(germanium+Ga)
However, germanium is the amount of exhaust gas reflux, and Ga is an inhalation air content.
[0032] therefore, as shown in drawing 3, in the above-mentioned low rotation field, in the specific region A0 whose output-torque T is less than [regularity torque T2] At the same time it makes exhaust air flow back to side ports 3 and 4 and performs the so-called exterior EGR As shown in drawing 2 , overlap the valve-opening period of an exhaust valve, and the valve-opening period of an inlet valve, and the so-called internal EGR is performed (detail after-mentioned). In the above-mentioned low rotation field, output-torque T performs control of performing neither Exterior EGR nor internal EGR, in above-mentioned low rotation quantity torque field A3 which is more than torque T2, and above-mentioned quantity rotation field A4.
[0033] In addition, although it becomes what (that is, inhalation-of-air negative pressure falls) an intake pressure decreases with the above-mentioned exhaust gas reflux, as shown in drawing 5 , Qa/A (Qa is an inhalation-of-air flow rate, and A is inhalation-of-air path area) does not fall, and even if inhalation-of-air negative pressure falls [inhalation-of-air negative pressure] in the field beyond constant value P1, when throttle opening is fixed, therefore, it does not produce a torque down. So, ECU40 consists of this example so that abbreviation etc. may spread inhalation-of-air negative pressure in case the above-mentioned throttle valve 17 is a close by-pass bulb completely on a top Norikazu constant value and it may carry out.
[0034] 3) On-off control of VVT10 : switch VVT10 in the above-mentioned specific region A0, and switch VVT10 to ON off by a change, other field A3, and A4.
[0035] 4) fuel-injection control: -- it is shown in drawing 6 -- as -- the above-mentioned low rotation low torque field A1 and under low rotation -- the torque field A2 and low rotation quantity torque field A3 -- setting -- further -- an engine speed -- several above-

mentioned rotations -- make injection perform only from (the slash field of drawing), and the pin center,large injector 25 in few fields more than fixed numbers, and make injection perform from the both sides of the pin center,large injector 25 and the side injector 24 in the other field rather than N1 In addition, you may make it make injection perform only from the side injector 24 in the latter field.

[0036] Next, an operation of this equipment is explained.

[0037] First, engine-speed N is less than one fixed rotational frequency N, and VVT10 operates, and throttle opening is switched to a delay side in the specific region (low rotation low load field) A0 of under constant value thetao, as the valve-opening period of exhaust valves 13 and 14 is shown in curvilinear 42B of drawing 2 . For this reason, after exhaust valves 13 and 14 opened from the piston bottom dead point this side after explosion and the combustion gas in a combustion chamber 2 was discharged through the exhaust air port 5 and 6 grades in each cycle, before exhaust valves 13 and 14 close in the next piston top dead center, inlet valves 11 and 12 open, new mind is introduced through suction ports 3 and 4 (the time of swirl control-valve 18 clausilium -- a suction port 3) in a combustion chamber 2, and the above-mentioned exhaust valves 13 and 14 are closed after that. Thus, when an exhaust valve valve-opening period and an inhalation-of-air valve-opening valve period overlap in part henceforth [a piston bottom dead point], the combustion gas which was once being discharged by the above-mentioned exhaust air ports 5 and 6 is again pulled back in a combustion chamber 2 by generating of the negative pressure by piston descent (internal EGR).

[0038] Furthermore, in this specific region A0, as shown in drawing 4 , when the EGR valve 34 opens by the opening according to throttle opening, exhaust gas flows back to a direct inspired air flow path. A pumping loss is also reduced, while more amounts of exhaust gas reflux are secured and generating of NOx is sharply controlled by this compared with the equipment which performs exhaust gas reflux only through the pin center,large port 7 like before by performing such the exterior EGR and above-mentioned internal EGR to coincidence.

[0039] After the above-mentioned exhaust valves 13 and 14 close, when the timing valve 15 opens in the next piston bottom dead point this side, the gaseous mixture currently formed in the pin center,large port 7 is drawn in a combustion chamber 2. And if it passes through a piston bottom dead point, while inlet valves 11 and 12 will close, shortly, the gas in a combustion chamber 2 is introduced into the above and reverse in the pin center,large port 7 with a piston rise, and the timing valve 15 is closed in the middle of a compression stroke after this installation. the gaseous mixture which consists of each pin center,large port 7 and a surge tank 22 here, since space in a feed zone is made into closing space By closing the timing valve 15 in the middle of a compression stroke as mentioned above The pressure in the pin center,large port 7 will be held at a pressure higher than combustion chamber 2 internal pressure at the time of valve opening of the following timing valve 15, and the gaseous mixture in the pin

center,large port 7 is again introduced by this differential pressure in a combustion chamber 2 at the time of valve opening next to the above-mentioned timing valve 15. namely, -- without it uses a special air pressurization means -- the gaseous mixture from the pin center,large port 7 to into a combustion chamber 2 -- while the structure of a part and equipment where supply will be made and an air pressurization means becomes unnecessary in this way is simplified, increase of the engine load by the drive of an air pressurization means is lost.

[0040] In addition, although flammability will generally fall and the yield of HC will increase by the increment in the above amounts of exhaust gas reflux According to the equipment of this example, in the specific region A0 where the above-mentioned exterior EGR and internal EGR are performed Evaporation and atomization of gaseous mixture are promoted and flammability is raised. the gaseous mixture from the pin center,large port 7 -- the heat of the combustion gas returned in a combustion chamber 2 in the case of the above-mentioned internal EGR while the inside of a combustion chamber 2 is stratification-ized by supply -- the above -- Furthermore, in order for HC component in the above-mentioned combustion gas to afterburn in a combustion chamber 2, in spite of the increment in the amount of exhaust gas reflux, generating of HC is suppressed and exhaust gas emission is kept good.

[0041] While it is switched to the advancing side as VVT10 is switched to OFF to such a specific region A0 by the other field, i.e., low rotation heavy load field A3, and high rotation field A4 and an exhaust valve valve-opening period shows curvilinear 42A of drawing 2 , and the duplication period of an exhaust valve valve-opening period and an inhalation-of-air valve-opening valve period is shortened at 0 or a very short period, the EGR valve 34 is also closed. Thus, by stopping Exterior EGR and the both sides of internal EGR, this field A3 and the high engine power demanded in A4 will be secured.

[0042] moreover, also in the above-mentioned specific region A0, as shown in the broken line L1 of drawing 4 , since the opening of the EGR valve 34 is extracted in order it is alike, to take and to decrease an EGR rate (that is, a load increases -- alike -- taking), the engine power corresponding to that operational status to which throttle opening increases is securable in this example. Moreover, since the EGR rate is set as the marginal EGR rate and abbreviation EQC which this maximum EGR rate does not make produce an engine torque down in the greatest condition, it is possible to secure the maximum amount of exhaust gas reflux in the range which does not spoil engine power.

[0043] Next, the 2nd example is explained based on drawing 7 and drawing 8 .

[0044] In this example, the surge tank 22 shown in said 1st example is connected to the above-mentioned common inlet-pipe 16a through the air supply path 60, and the air pump (air pressurization means) 58 is formed in the middle of this air supply path 60. This air pump 58 is connected with the drive shaft 52 of each timing valve 15 through the drive transfer device 54 in this example, a interlocking drive is carried out with the above-mentioned drive shaft 52, and the electromagnetic clutch 56 switched to the

condition of separating from the condition of connecting both is formed between this air pump 58 and the drive transfer device 54.

[0045] In each pin center,large port 7, the pin center,large port throttle valve 26 by which a closing motion drive is carried out by interlocking mutually with the actuator of **** is formed, and the flow passage area in the pin center,large port 7 is adjusted by opening change of this pin center,large port throttle valve 26.

[0046] In addition to the control shown in said 1st example, ECU40 is constituted so that opening control of the above-mentioned pin center,large port throttle valve 26 may be performed. Opening of the pin center,large port throttle valve 26 is made into max, and, specifically, control of making opening of the pin center,large port throttle valve 26 into max is performed in the above-mentioned specific region A0 by fields other than the above-mentioned specific region A0, i.e., low-speed quantity torque (high throttle opening) field A3, and high rotation field A4.

[0047] according to such equipment, since pressurization air is supplied little by little to the downstream of the pin center,large port throttle valve 26 while opening of the pin center,large port throttle valve 26 was made into min and the timing valve 15 has closed, when the timing valve 15 opens, gaseous mixture supplies at once in a combustion chamber 2 in the above-mentioned specific region A0 -- having -- after that -- gaseous mixture -- gaseous mixture to which the amount of supply decreases rapidly -- supply is made. It is urged to stratification-ization in a combustion chamber 2 by this, and increase of HC yield resulting from exhaust gas reflux is controlled. On the other hand, in low-speed quantity torque field A3 and high rotation field A4 as which an output is required comparatively, by considering the pin center,large port throttle valve 26 as full open, and always supplying pressurization air, much gaseous mixture will be stabilized by the inside of a combustion chamber 2, and it will be supplied.

[0048] Next, the 3rd example is explained based on drawing 8 .

[0049] In this example, it adds to the 1st valve-opening period shown in the curve 46 of drawing 2 in the equipment shown in said 1st example. Also in the period of the time of being at the next time, the 2nd valve-opening period, i.e., explosion line, shown in the curve 48 of drawing 8 , and passing a little next piston bottom dead point from a front time rather than the valve-opening stage (left end of drawing 8 curvilinear 42A) of the exhaust valve in fields other than specific region A0 The configuration of the cam for a drive is set up so that the timing valve 15 may be opened.

[0050] In addition to combustion gas being stored in the pin center,large port 7 by the time of termination of the 1st valve-opening period shown with the above-mentioned curve 46 according to such equipment, in the 2nd valve-opening period shown with the above-mentioned curve 48 Since the elevated-temperature high-pressure combustion gas after explosion is further pushed in in the pin center,large port 7, while evaporation atomization of the gaseous mixture in the pin center,large port 7 is promoted more with the heat of this combustion gas The pressure in the pin center,large port 7 at the time of

valve opening of the following timing valve 15 (at namely, the time of initiation of the 1st valve-opening period) will be heightened more. Therefore, it can also set to the low load field where the pressure and temperature in the combustion chamber 2 in each stroke are comparatively low, the differential pressure of the combustion chamber 2 internal pressure and pin center,large port 7 internal pressure at the time of valve opening of the timing valve 15 can be secured sufficiently greatly, and it becomes possible to supply more certainly the gaseous mixture by which evaporation atomization was fully carried out to such differential pressure being in the pin center,large port 7 to a combustion chamber 2.

[0051] In addition, it is also possible for this invention not to be limited to the above examples, but to take the following modes as an example.

[0052] (1) When performing internal EGR and Exterior EGR by making a low load field into a specific region A0 like said each example, throttle opening is detected as mentioned above, and also an intake pressure is detected and this may be made to make the field below fixed a specific region. Moreover, only based on an engine load, it may be made to control the above-mentioned exhaust gas reflux irrespective of an engine speed.

[0053] (2) Although said 1st example showed what delays the both sides of the clausilium stage of exhaust valves 13 and 14, and a valve-opening stage by actuation of VVT10 in the specific region A0, even if it delays only the clausilium stage of exhaust valves 13 and 14 in a specific region A0, for example by change-over of a cam etc., it becomes possible to perform the above-mentioned internal EGR. However, if the both sides of the clausilium stage of exhaust valves 13 and 14 and a valve-opening stage are delayed by VVT10 in the 3rd example of the above In the field (namely, field with little need of raising the pressure and temperature in the pin center,large port 7 by installation of the combustion gas in the 2nd valve-opening period) where the pressure and temperature in a combustion chamber 2 are higher than a specific region A0 By being able to expand the duplication period of the valve-opening period of exhaust valves 13 and 14, and the valve-opening period of the above 2nd, and missing combustion gas to exhaust air port 5 and 6 side positively in such a duplication period It can prevent introducing this combustion gas (namely, inert gas) in the pin center,large port 7 beyond the need, and high engine power can be secured. Moreover, it can also prevent having a bad influence on the fuel injection by the pin center,large injector 25 in this pin center,large port 7 by overpressure rise in the pin center,large port 7.

[0054] (3) The duplication period of said exhaust valve valve-opening period and an inhalation-of-air valve-opening valve period may be a period which faces across a piston top dead center, and may be a period after a piston top dead center. However, during a duplication period, in the case of the latter, the piston will surely descend, and there is an advantage which can secure more amounts of internals EGR (capacity pulled back in a combustion chamber 2 from the exhaust air ports 5 and 6) with the negative

pressure by descent of such a piston in it.
[0055] (4) Although the 1st example of the above showed what makes the EGR valve 34 a close by-pass bulb completely in field A3 other than specific region A0, and A4, and does not perform Exterior EGR at all, in this invention, the amount of EGR(s) in fields other than a specific region may be set as a minute amount smaller than the amount of EGR(s) in a specific region.
[0056] (5) In this invention, the main inhalation-of-air number of connections was not asked, but this could be single and could be formed three or more.
[0057]
[Effect of the Invention] above -- this invention -- the main suction port and gaseous mixture -- the equipment in which the both sides of a feed zone do opening to a common combustion chamber -- setting -- the above -- gaseous mixture -- in the specific region included in the operating range to which gaseous mixture is supplied from a feed zone Expand the duplication period of the valve-opening period of the above-mentioned exhaust valve, and the valve-opening period of the above-mentioned inlet valve within limits to which the valve-opening period of the above-mentioned exhaust valve does not overlap the valve-opening period of the above-mentioned closing motion valve compared with other fields, and internal EGR is performed. Furthermore, since exhaust gas is made to flow back to the above-mentioned main suction port and it is made to perform Exterior EGR the above -- gaseous mixture -- compared with the conventional equipment with which exhaust gas flows back, NOx generating can be sharply suppressed with the both sides of the above-mentioned internal EGR and Exterior EGR in the above-mentioned specific region to a feed zone. and -- this specific region -- the above -- gaseous mixture -- the gaseous mixture from a feed zone -- the heat of the combustion gas returned to a combustion chamber in the case of the above-mentioned internal EGR while stratification-izing a combustion chamber by supply -- the above -- evaporation and atomization of gaseous mixture can be promoted, and since HC component in the combustion gas returned to the above-mentioned combustion chamber can be further afterburned in this combustion chamber, aggravation of the exhaust gas emission by generating of HC can be suppressed in spite of the increment in the amount of EGR(s).
[0058] Here, with equipment according to claim 2, since the above-mentioned specific region is made into the low load field, while securing NOx depressant action sufficient in this low load field, and a reduction operation of a pumping loss, in the heavy load field which are fields other than the above-mentioned specific region, it is effective in the high power demanded in this heavy load field being securable by stopping the above-mentioned internal EGR and Exterior EGR.
[0059] Furthermore, with equipment according to claim 3, also in the above-mentioned specific region, since he is trying to stop the amount of external EGR(s) as an engine load increases, it is effective in the engine power for which it was suitable with actual

operational status being securable.
[0060] equipment according to claim 4 -- the above -- gaseous mixture, while making space in a feed zone into closing space In addition to the above-mentioned valve-opening period (namely, 1st valve-opening period), a closing motion valve is opened in the 2nd valve-opening period (period when the valve-opening stage of a closing motion valve is earlier than the valve-opening stage of an exhaust valve). this 2nd valve-opening period -- the high-pressure combustion gas of the above-mentioned combustion chamber -- further -- gaseous mixture -- the inside of a feed zone -- pushing in -- gaseous mixture -- by carrying out the pressure up of the inside of a feed zone further the gaseous mixture at the time of a closing motion valve-opening valve, since he is trying to secure big differential pressure between combustion chambers in a feed zone without it uses a special air pressurization means by using such differential pressure -- gaseous mixture -- it can supply good and simplification of the structure of equipment and mitigation of an engine load can be achieved by the abbreviation of the above-mentioned air pressurization means. moreover, the above -- gaseous mixture -- the gaseous mixture by increase of the differential pressure according to installation of the above-mentioned combustion gas in the above low load fields although the installation of the combustion gas into a feed zone itself becomes the factor which reduces the flammability of gaseous mixture, and the high temperature of combustion gas -- flammability can be raised on the contrary by promotion of evaporation atomization of the gaseous mixture in a feed zone.
[0061] With equipment according to claim 5, furthermore, in the above-mentioned specific region, i.e., a low load field Since he is trying to delay not only the clausilium stage of the above-mentioned exhaust valve but a valve-opening stage compared with other fields delay of this valve-opening stage -- the duplication period of the valve-opening period of an exhaust valve, and the valve-opening period of the above 2nd -- reducing -- gaseous mixture, while the high pressure in a feed zone is maintainable fields other than the above-mentioned specific region, especially combustion gas -- gaseous mixture -- even if it does not introduce in a feed zone -- sufficient gaseous mixture -- in the heavy load operating range which can secure feed zone internal pressure By bringing forward the valve-opening stage of an exhaust valve, expanding the above-mentioned duplication period, and missing combustion gas positively to an exhaust air port side in this duplication period rather than the above-mentioned specific region the above -- gaseous mixture -- while preventing installation of the excessive combustion gas into a feed zone and securing good flammability -- gaseous mixture -- there is effectiveness which it can also prevent that the inside of a feed zone carries out a pressure up superfluously, and has a bad influence on fuel injection.
[0062] With equipment according to claim 6, since it is set as an amount almost equal to the amount of marginal reflux to which the amount of new air conduction ON from the main suction port begins to decrease with the peak price of the amount of exhaust air

reflux by the above-mentioned exhaust air reflux means to increase of this amount of exhaust air reflux, the maximum NOx reduction effectiveness in within the limits which does not have a bad influence on engine power can be acquired.

[0063] With equipment according to claim 7, the valve-opening stage of the above-mentioned inlet valve is delayed rather than a piston top dead center, coincidence, or this. Since the duplication period of the valve-opening period of an exhaust valve and the valve-opening period of an inlet valve is set as the period, i.e., the period to which the piston is surely descending, after the above-mentioned piston top dead center, The combustion gas discharged from the exhaust air port can be more certainly pulled back to a combustion chamber with the negative pressure by the above-mentioned piston descent, and it is effective in the ability to obtain much more amounts of internals EGR by this.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the whole engine block diagram in the 1st example of this invention.

[Drawing 2] It is the graph which shows the valve-opening timing of each valve set up in the above-mentioned engine.

[Drawing 3] It is the graph which shows the contents of EGR control corresponding to the engine speed and output torque in the above-mentioned engine.

[Drawing 4] It is the graph which shows the contents of control and the on-off control of VVT whenever [corresponding to whenever / throttle valve-opening / in the above-mentioned engine / EGR valve-opening].

[Drawing 5] It is the graph which shows the relation of the inhalation-of-air negative pressure and the inhalation-of-air rate of flow in the above-mentioned engine.

[Drawing 6] It is the graph which shows the contents of the fuel-injection control corresponding to the engine speed and output torque in the above-mentioned engine.

[Drawing 7] It is the whole engine block diagram in the 2nd example of this invention.

[Drawing 8] It is the graph which shows the valve-opening timing of each valve set up in the 3rd example of this invention.

[Description of Notations]

1 Cylinder

2 Combustion Chamber

3 1st Side Port (the Main Suction Port)

4 2nd Side Port (the Main Suction Port)

5 Six Exhaust air port

7 Pin Center,large Port (Gaseous Mixture Feed Zone Configuration)

10 VVT (Stage Adjustable Means)

11 12 Inlet valve
13 14 Exhaust valve
16 Inlet Pipe
17 Throttle Valve
20 Throttle Sensor
22 Surge Tank (Gaseous Mixture Feed Zone Configuration)
25 Pin Center,large Injector
28 Exhaust Manifold
32 EGR Path (Exhaust Air Reflux Means is Constituted)
34 EGR Valve (Exhaust Air Reflux Means is Constituted)
40 ECU (Stage Control Means and Exhaust Air Reflux Control Means)

[Translation done.]